13.0 NOISE AND VIBRATION

This chapter describes the location of potential noise and vibration sensitive receptors within the study area for the proposed LYNX Blue Line Extension Northeast Corridor Light Rail Project (LYNX BLE). It also discusses the potential long-term and short-term affects to these receptors for the alternatives under consideration in this Draft Environmental Impact Statement (EIS). Mitigation measures are identified, where noise or vibration impacts are predicted. Additional technical information may be found in the supporting *Noise and Vibration Technical Report* (June 2010), *Noise and Vibration Technical Report Addendum #1* (June 2010) and *Noise and Vibration Technical Report Addendum #2* (June 2010).

13.1 Noise and Vibration Impact Assessment Guidelines

The process for assessing the potential impact for noise and vibration reported in this Draft EIS followed the U.S. Federal Transit Administration (FTA) guidance manual *Transit Noise and Vibration Impact Assessment* (May 2006). This process involves three levels of assessment: 1) screening, 2) general assessment and 3) a detailed assessment. A screening is typically done for locating project alignments and involves the identification of noise sensitive receptors along a corridor. A general assessment identifies the existing noise levels, the noise sensitive receptors along a corridor, projects a project-related noise level, estimates potential impact and recommends a range of mitigation options. For purposes of this Draft EIS, a general assessment was conducted. A detailed assessment will be completed prior to the Final EIS in order to identify specific noise conditions and mitigation methods for each sensitive receptor.

13.1.1 Human Perception of Noise

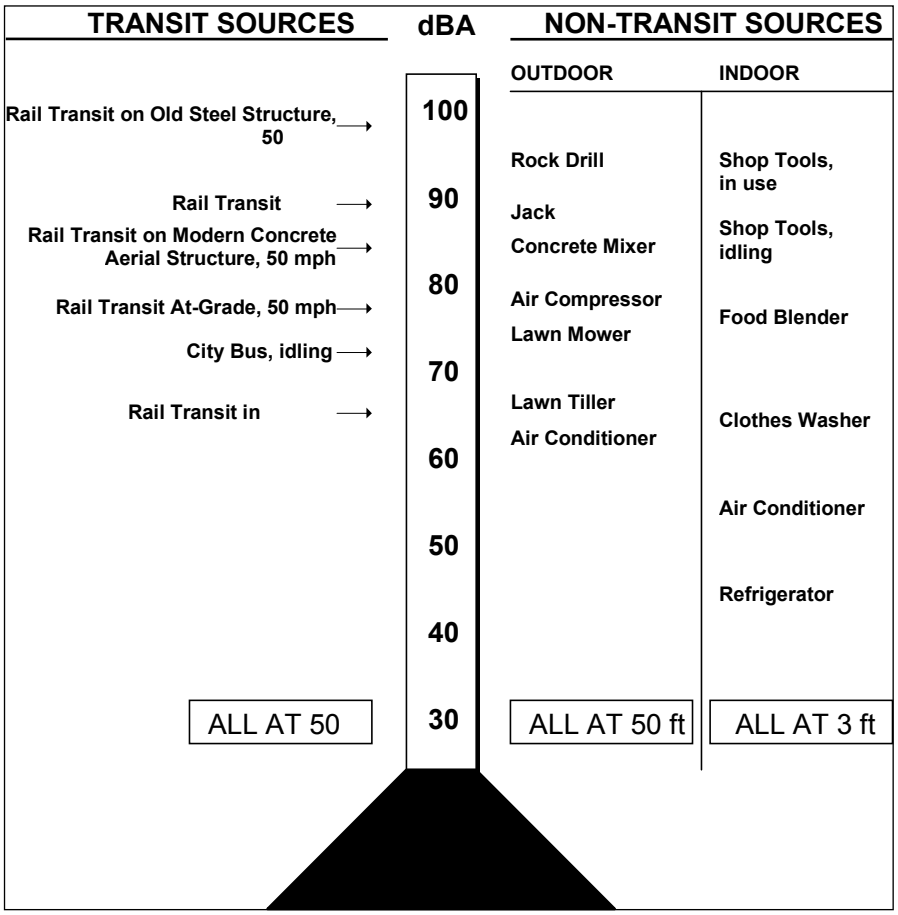
Noise is typically defined as unwanted or undesirable sound. Urban environments are comprised of "background noise" consisting of daily urban sounds such as traffic, air conditioners, telephones, bird calls and other familiar noises. Human reaction to sounds above this background noise is dependent on the intensity or level (such as high or low pitch sounds), the frequency and the variation in the sound level. The U.S. Environmental Protection Agency (EPA) has studied human annoyance to noise and has quantified the level of noise that most humans recognize in an urban environment as new noise. Community reaction in the EPA studies identified ranges of reaction from "no reaction" to "vigorous action." The body of research developed by the EPA on the subject of noise served as the basis for the development of the FTA guidance manual for identifying noise and vibration impacts for transit projects.

Noise is generated in two ways: through the air as "airborne noise" and through the ground as "ground-borne noise." Airborne noise is the most common form of noise while ground-borne noise is created from vibration, such as the rattling of dishes that occurs in houses located close to freight railroad tracks.

Noise is measured in a logarithmic unit called a decibel (dBA). Human perception of noise is measured in decibels on a scale that has been weighted to middle and high frequency sounds that are more discernible to humans. This scale is called an A-weighted scale. By using this scale, the range of normally encountered sound can be expressed by values from 0 to 120 decibels. On a comparative basis, a 3-decibel change in sound level generally represents a barely-noticeable change outside the laboratory, whereas a 10-decibel change in sound level would typically be perceived as a doubling (or halving) in the loudness of a sound.

Noise levels are commonly measured and analyzed in two ways: Leq (sound level equivalent) and Ldn (24-hour day night average). Leq is a steady sound level over a specified period of time, such as one hour. It is often used to determine noise near areas where quiet is essential at all hours, such as a school or a park. The Ldn is commonly used to describe the 24-hour day-night average and assigns a 10-decibel penalty to night-time hours. Ldn is commonly used to analyze noise impacts in areas where people sleep. Figure 13-1 provides examples of typical noise environments and criteria. In most communities, Ldn is generally found to range between 55 dBA and 75 dBA. As shown in Figure 13-1, this spans the range between an "ideal" residential environment and the threshold for an unacceptable residential environment according to U.S. Federal agency criteria.

Figure 13-1
Typical Noise Environments



Source: FTA, *Transit Noise and Vibration Impact Assessment*, May 2006.

13.1.1.1 Federal Transit Administration Noise Criteria

The general noise assessment identifies buildings or properties within proximity to the project area with the potential to experience a noise impacts. With respect to rail noise, the FTA has established criteria to assess potential impacts of transit projects. These criteria do not generally apply to industrial or commercial areas since they are generally compatible with high noise levels. These criteria group noise sensitive land uses into the following three categories:

Category 1: Buildings or parks where quiet is an essential element of their intended purpose.

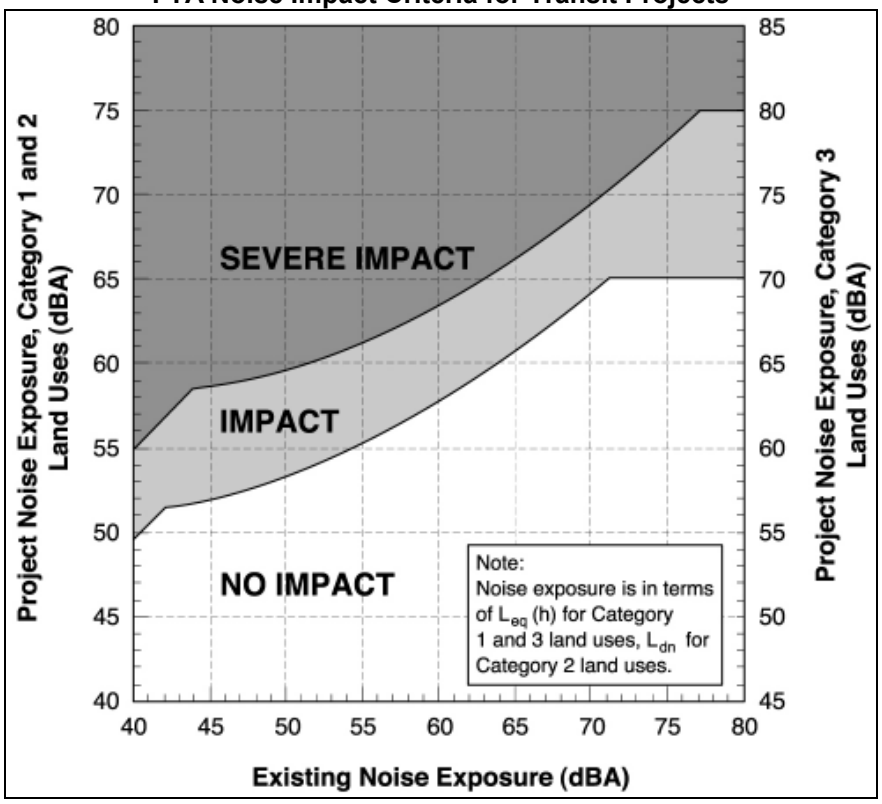
Category 2: Residences and buildings where people normally sleep. This includes residences, hospitals and hotels where night-time sensitivity is assumed to be of utmost importance.

Category 3: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material.

Noise impacts resulting from a proposed project are determined by comparing the existing and future project-related outdoor noise levels as illustrated in the graph provided in Figure 13-2. Existing noise exposure is shown on the x-axis, horizontal, of the graph, and the y-axis, vertical, shows the additional noise exposure from the transit project that would cause either moderate or severe impact. Essentially, as the existing level of ambient noise increases, the allowable level of transit noise also increases, but the total amount, by which that community's noise can increase, without an impact, is reduced. Noise level

increases, defined by the FTA guidance as “moderate impacts” or “severe impacts”, occur when the existing levels are surpassed by more than the allowable increase by the project-related noise.

Figure 13-2
FTA Noise Impact Criteria for Transit Projects



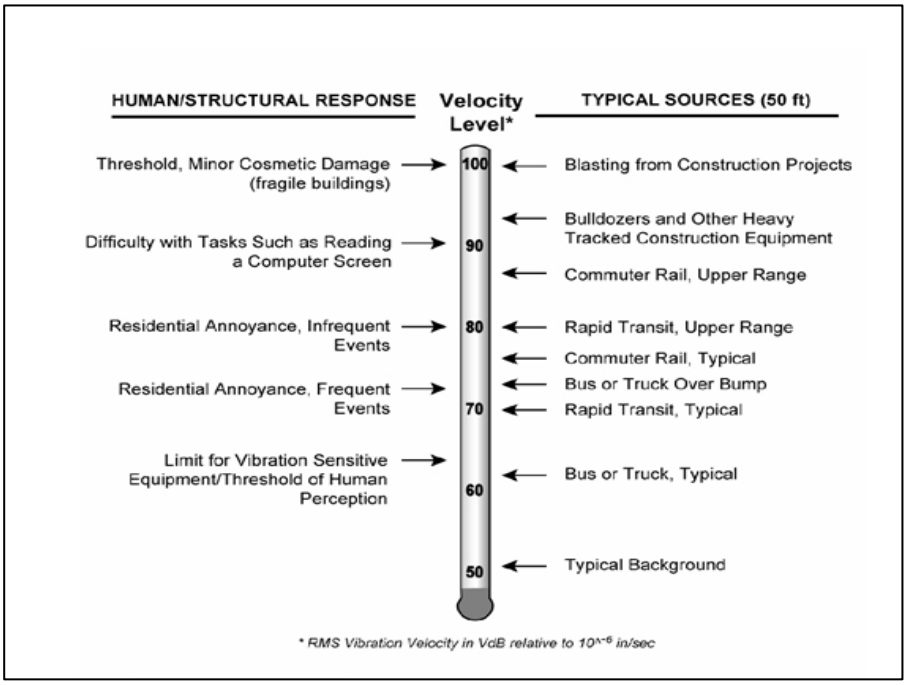
Source: FTA, *Transit Noise and Vibration Impact Assessment*, May 2006.

13.1.1.2 Human Perception of Ground-Borne Vibration

In addition to noise, rail transit projects have the potential to cause ground-borne vibration. Ground-borne vibration generally occurs most frequently with transit systems that are built underground. However, at-grade rail transit projects can also result in ground-borne vibration under certain soil and rock conditions. Ground-borne vibration is vibration that moves through the ground to a stationary object, such as a building. An example of ground-borne vibration is movement of wall hangings as a freight train passes by a residence. Ground-borne vibration from transit vehicles is usually characterized in terms of the “smoothed” root mean square (RMS) vibration velocity level, in decibels (VdB), with a reference quantity of one micro-inch per second. VdB is used in place of dB to avoid confusing vibration decibels with sound decibels.

Figure 13-3 illustrates typical ground-borne vibration levels for common sources. As shown, the range of interest is from approximately 50 to 100 VdB, from imperceptible background vibration to the threshold of damage. Although the approximate threshold of human perception of vibration is 65 VdB, annoyance is usually not significant unless the vibration exceeds 70 VdB.

Figure 13-3
Typical Vibration Levels



Source: FTA, *Transit Noise and Vibration Impact Assessment*, May 2006.

13.1.1.3 Federal Transit Administration Vibration Criteria

Similar to the FTA noise criteria, the FTA vibration criteria are based on three land use categories, although the categories are somewhat different. One important difference is that outdoor spaces are not included in Category 3 for vibration. This is because human annoyance from ground-borne vibration requires the interaction of the ground vibration with a building structure. Consequently, the criteria apply to indoor spaces only and there are no vibration impact thresholds for outdoor spaces such as parks. Table 13-1 illustrates the FTA ground-borne vibration impact criteria, based on land use and train frequency. For residential buildings (Category 2), the threshold applicable to this project is 72 VdB. The applicable threshold for schools and churches (Category 3) is 75 VdB. There are some buildings, such as concert halls, recording studios and theaters that can be very sensitive to vibration but do not fit into any of the three categories listed in Table 13-1. These buildings usually warrant special attention during the project development process of a transit project due to their sensitivity.

It should also be noted that Table 13-1 includes separate FTA criteria for ground-borne noise, the "rumble" that can be radiated from the motion of room surfaces in buildings due to ground-borne vibration. Although expressed in dBA, which emphasizes the more audible middle and high frequencies, the criteria are set significantly lower than for airborne noise to account for the annoying low-frequency character of ground-borne noise. Because airborne noise often masks ground-borne noise for above-ground (i.e. at-grade or elevated) rail systems, ground-borne noise criteria are primarily applied to subway operations where airborne noise is not a factor. For the at-grade transit system associated with the proposed Light Rail Alternative and Light Rail Alternative – Sugar Creek Design Option, ground-borne noise criteria are applied only to buildings with sensitive interior spaces that are well insulated from exterior noise where a potential for exposure may occur.

Table 13-1
Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

Land Use Category	GBV Impact Levels (VdB re: 1 micro-inch / sec)			GBN Impact Levels (dBA re: 20 micro Pascals/sec)		
	Frequent Events [1]	Occasional Events [2]	Infrequent Events [3]	Frequent Events [1]	Occasional Events [2]	Infrequent Events [3]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB	65 VdB	65 VdB	n/a [4]	n/a [4]	n/a [4]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primary daytime use	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

[1] "Frequent Events" is defined as more than 70 vibration events per day.
[2] "Occasional Events" is defined as between 30 and 70 vibration events per day.
[3] "Infrequent Events" is defined as less than 30 vibration events per day.
[4] n/a means "not applicable". Vibration-sensitive equipment is not sensitive to ground-borne noise.
Source: FTA, *Transit Noise and Vibration Impact Assessment*, May 2006.

13.2 Affected Environment

Noise and vibration-sensitive land uses were identified by screening Geographic Information Systems (GIS) data for buildings with residential or institutional uses nearby the proposed alignment. For rail traffic from a light rail transit project such as the LYNX BLE, the FTA-defined noise screening distance for locations with unobstructed views is 350 feet. The screening distance when intervening buildings are present is 175 feet. Vibration screening distances are 450, 150 and 100 feet for vibration Category 1, 2 and 3 land uses, respectively. Field observations were made to identify and confirm sensitive land use locations within the larger study area to ensure that the maximum screening distance of 450 feet for vibration was captured.

13.2.1 Existing Ambient Noise Levels

Noise-sensitive receptors along the project corridor were identified based on preliminary alignment drawings, aerial photographs, visual surveys and land use information. Monitoring sites were selected on the basis of several factors, the most important of which was the site's potential sensitivity to changes in noise or vibration levels. Each site selected was either representative of a unique noise environment or that of similarly situated receptors nearby. While the majority of the selected sensitive receptors are residential in nature, schools, churches and medical offices were also identified. Both long-term (24-hour) and short-term monitoring was conducted at numerous sites along the proposed alignment. A tabulation of the existing noise levels is provided in Table 13-2. Monitoring locations are shown on Figures 13-4a and 13-4b.

13.2.2 Existing Vibration Conditions

Existing vibration levels near sensitive receptors would primarily be the result of vehicular traffic on local roadways and existing rail activity. UNC Charlotte provided vibration data that was previously collected at two of their existing academic buildings, Duke Centennial Hall and Grigg Hall. At Duke Centennial Hall, the greatest measured vertical vibration level was approximately 46 VdB (monitored in 2002). At Grigg Hall, the greatest measured vertical vibration level was approximately 43 VdB (monitored in 2007). The Duke Centennial Hall monitoring was taken prior to the actual construction of the building, while the Grigg Hall monitoring was taken within the buildings existing research facilities, which incorporates the use of a dual vibration isolation system. As such, the most accurate measure of existing vibration would be at Duke Centennial Hall as readings were taken on solid ground. While the Grigg Hall monitoring is not representative of a true measure of existing vibration conditions, it does serve to demonstrate the effectiveness of the current vibration isolation system within the building.

Table 13-2
Noise Monitoring Results – Existing Noise Exposure

Site#[1]	Monitoring Location Description	Date	Duration (hour)	Existing Noise Exposure	
				Ldn[2]	Leq[3]
1	United Presbyterian Church, 201 East 7th Street	10/04/2005	1	61.0	63.0
2	Alpha Mill Apartments, 220 Alpha Mill Lane	10/01/2008	1	71.0	59.1
3	House, 234 Parkwood Avenue	10/01/2008	1	72.7	73.9
4	House, 405 19th Street	10/03/2005	24	69.0	69.0
5	House, 423 East 22nd Street	10/01/2008	1	60.1	56.0
6	3312 Benard Avenue[4]	n/a	n/a	71.3	n/a
6	GDR Holiness Church, 2604 North Brevard Street	10/04/2005	1	59.0	61.0
7	Highland Mill Residential Apts., 2901 North Davidson Street	10/01/2008	1	63.1	61.3
8	The Colony , 3440 North Davidson Street (1st floor commercial, 2nd floor residential)	10/03/2005	24	69.0	71.0
9	House, 4031 Bearwood Avenue[5]	n/a	n/a	65.0	n/a
10	House, 342 St. Anne Place	12/15/2008	24	71.4	58.8
11	Elmore Mobile Home Park, 4832 North Tryon Street	10/02/2008	1	53.8	50.2
12	Crossroads Charter High School, 5500 North Tryon Street/US-29	10/02/2008	1	69.6	71.8
13	Pines Mobile Home Park, 5635 North Tryon Street	10/02/2008	1	54.0	50.8
13	Harbor Baptist Church, 5801 Old Concord Road	10/02/2008	1	59.8	62.0
15	Holiday Motel, 6001 North Tryon Street/US-29	10/03/2005	24	70.0	68.0
16	House, 201 Kingview Drive	10/08/2008	24	63.6	66.4
17	InTown Suites, 110 Rocky River Road	10/04/2005	1	62.0	64.0
18	Residence Inn by Marriott, 8503 North Tryon Street at Ken Hoffman Drive	10/06/2008	1	66.1	66.4
19	Carolinas Medical Center-University, 8800 North Tryon Street	10/06/2008	1	58.1	60.1
20	UNC Charlotte Duke Centennial Hall	10/06/2008	1	63.3	65.3
21	Ashford Green Apartments, 230 Barton Creek Drive	10/03/2005	24	62.0	61.0
22	Residence, UNC Charlotte Laurel Hall	10/08/2008	24	62.1	55.3
23	Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	10/07/2008	1	50.5	52.5
24	Hunt Club Apartments, 208 Northbend Drive	10/04/2005	1	63.0	65.0
25	Queen's Grant Mobile Homes, 124 Carnival Street	10/06/2008	1	55.4	52.5

[1] See Figures 13-4a and 13-4b.
[2] Day-Night Sound Level (Ldn): Used to characterize community noise over a 24-hour period.
[3] Equivalent Sound Level (Leq): A descriptor used to characterize loudness of fluctuating noise. Leq represents a constant sound that, over the specified period, has the same sound energy as the fluctuating sound.
[4] Represents a calculated existing noise level derived from existing rail traffic.
[5] Noise level obtained from Table 5-7 of the FTA *Transit Noise and Vibration Impact Assessment*, May 2006.
Source: STV, *Noise and Vibration Technical Report*, 2010; STV, *Noise and Vibration Technical Report Addendum #1*, 2010; STV, *Noise and Vibration Technical Report Addendum #2*, 2010.

13.3 Environmental Consequences

This section includes an evaluation of the direct noise and vibration impacts of the No-Build Alternative, the proposed Light Rail Alternative and the Light Rail Alternative – Sugar Creek Design Option. Construction-related impacts, along with avoidance, minimization, and mitigation measures, are discussed in Chapter 18.0: Construction Impacts.

13.3.1 Noise Impacts

The prediction of noise impacts involves a determination of project-related noise levels at several noise sensitive locations and then comparing them to the applicable FTA noise criteria. These locations included single-family residences, multi-family apartment buildings, hotels, schools, churches, medical facilities and passive parks where quiet is essential.

13.3.1.1 No-Build Alternative

Light rail would not be constructed under this alternative; therefore, no noise impacts would occur.

13.3.1.2 Light Rail Alternative

FTA's general assessment for noise compares the project-related noise against existing conditions, obtained from field measurements, to determine the potential for impact. Project-related noise is calculated for each noise receiver and accounts for all anticipated noise sources. Noise sources associated with light rail are typically generated from the following elements:

- Wheel/rail interaction;
- Horns (at and approaching grade crossings) and crossing gate bells;
- Traction power substations;
- Aerial structures that may amplify sound;
- Traction motor;
- Vehicular access to stations; and
- Maintenance and storage facilities.

Table 13-3 lists the sensitive receptors that would be likely to experience a moderate or severe impact. Noise impacts are likely to occur at 14 Category 1 and Category 2 land uses (or representative clusters), including 11 moderate impacts and two severe impacts. The footnotes for Table 13-3 identify if noise would primarily result from noise sources other than wheel/rail interaction. One receptor, UNC Charlotte's Laurel Hall may experience noise impacts resulting from wheel squeal.

Impacts were predicted at six separate impact locations along the alignment. At the Pines Mobile Home Park, a total of 26 individual residential building properties would experience a moderate impact. At the Mallard Creek Apartments, six individual residential buildings would experience a moderate impact, while two individual residential building properties would experience a severe impact. The remaining four locations would be moderately impacted; including: the InTown Suites Hotel building, Residence Inn by Marriott Hotel building, Carolinas Medical Center-University (CMC-University) and one area of noise-sensitive parkland at the Kirk Farm Fields Wetland Viewing Area. In addition to the predicted noise impacts, the potential for wheel squeal noise was identified at two locations along the alignment; the UNC Charlotte – Laurel Hall Student Residence Hall and the Kirk Farm Fields Wetland Viewing Area. Noise impact locations are shown in Figure 13-5. Noise impacts would not occur at any of the Category 3 land uses as a result of the proposed Light Rail Alternative.

<u>Train Operations / Grade Crossings / Substations:</u>
With the proposed project, light rail operations would consist of 234 total train movements per day. These movements represent the number of times a receptor would be exposed to a train passby during a 24-hour period. Procedures in the FTA's Transit Noise and Vibration Impact Assessment manual were used to forecast noise levels due to wheel/rail interaction as well as the blowing of light rail horns and grade crossing bells where applicable. It was determined that 26 residences in the Pines Mobile Home Park would be moderately impacted from light rail operations on the elevated bridge over Old Concord Road into the median of North Tryon Street/US-29. The InTown Suites Hotel would be moderately affected by increased noise levels from a substation. At this location, predicted substation noise levels were also added to those noise levels predicted for the light rail operations and grade crossings. The Residence Inn by Marriott would be moderately affected by the addition of a signalized intersection at North Tryon Street/US-29 and Ken Hoffman Drive where the light rail would be required to use horns at and approaching the grade crossing and the crossing gate bells. Likewise, CMC–University would also be

Table 13-3
Noise Impact General Assessment (2009) Category 1 and 2 Land Uses, Light Rail Alternative

Description	Land Use	Existing Ldn (dBA)	Speed (mph)	Distance to Source (feet)	Impact Thresholds		Project - Related Prediction Ldn (dBA)	Type of Impact	# Impacts
					Impact	Severe			
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	54	35	230	55	61	58.1	Moderate	4-SFU
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	54	35	300	55	61	57.0	Moderate	22-SFU
InTown Suites, 110 Rocky River Rd.	Hotel	62	40	1,100[3]	59	64	59.6	Moderate	1-Hotel
Residence Inn by Marriott, 8503 North Tryon Street at Ken Hoffman Drive	Hotel	66	35	200[3]	61	67	61.6	Moderate	1-Hotel
Carolinas Medical Center – University, 8800 North Tryon Street	Hospital	58	35	290[4]	57	62	58.0	Moderate	1-Hospital
Campus Housing, UNC Charlotte Laurel Hall	Residence Hall	62	35	218	59	64	54.4	Potential wheel squeal[1]	1-Residence Hall
Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	MFR	51	40	105	54	60	60.7	Severe	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (2)	MFR	51	40	240[3]	54	60	58.2	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (3)	MFR	51	40	390[3]	54	60	56.5	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (4)	MFR	51	40	125	54	60	59.6	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (5)	MFR	51	40	530[3]	54	60	54.7	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (6)	MFR	51	40	650[3]	54	60	56.4	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (7)	MFR	51	40	750[3]	54	60	54.2	Moderate	1-MFU
Mallard Creek Apartments, 420 Michelle Linnea Drive (8)	MFR	51	40	100	54	60	63.8	Severe	1-MFU
Kirk Farm Fields Wetland Viewing Area, North Tryon Street/US-29 at Mallard Creek Church Road	Park	52.5	25	150[3]	59	65	59.0	Moderate Potential wheel squeal[1]	1-Park

SFR = Single-family Residential, MFR = Multi-family Residential, MU = Mixed Use, SFU = Single-family Unit, MFU = Multi-family Unit
[1]Laurel Hall student residence is located near a track curve which could result in intermediate wheel squeal. However, wheel squeal was not included in noise predictions because wheel squeal noise levels are highly variable, making accurate noise projections extremely complex.
[2]Distance to VLMF
[3] Distance to at-grade crossing
[4] Distance to access road
Source: STV, *Noise and Vibration Technical Report*, 2010; STV, *Noise and Vibration Technical Report Addendum #2*, 2010.

moderately affected due to the addition of a signalized intersection, and resulting grade crossing noise, along North Tryon Street/US-29 at JM Keynes Drive. Finally, at the Mallard Creek Apartments, six buildings would be moderately impacted and two buildings would be severely impacted from light rail operations and the light rail grade crossing of Mallard Creek Church Road.

Stations and Park-and-Ride Lots:
Noise due to the operation of a light rail station would be primarily associated with automobile and bus traffic entering and exiting station drop-off and parking areas. The proposed stations would all be in areas where existing roadway vehicle traffic is substantial on nearby streets or freeways that would result in a small increment in noise arising from additional traffic bound to or from the light rail stations. As a result, no additional impacts are anticipated as a result of station noise and an analysis of station noise was not required. Vehicular access roads were also considered in the analysis and the results show that access roads would not cause an impact at any of the park-and-rides.

Wheel Squeal:
Based on the criteria for wheel squeal described previously, two potentially affected locations were identified along the proposed Light Rail Alternative. These locations include the UNC Charlotte Laurel Hall student residence and the Kirk Farms Fields Wetland Viewing Area. Both locations would be located near track curves which could result in intermediate wheel squeal as these curves have a turning radius of less than 450 feet.

Charlotte Research Institute (CRI) at the UNC Charlotte: The noise prediction results at the CRI buildings indicate that future noise levels would not result in impacts at any of the CRI buildings. The proposed Light Rail Alternative would be located in a depressed trackway in the vicinity of these buildings. Therefore, predicted noise levels would be reduced to even lower levels than those predicted due to the barrier like effect of the below-grade retaining walls. Reductions could range anywhere from six to 15dB.

Vehicle Light Maintenance Facility: The operation of the proposed VLMF would be primarily associated with light rail vehicles exiting the facility during morning peak periods, light rail vehicles entering the facility at the end of the day, maintenance and cleaning of vehicles, and movement of the light rail vehicles within the facility. The VLMF would be located at the site of the existing Norfolk Southern Intermodal Yard along Brevard Street. Most of the properties near the VLMF are industrial or commercial in nature, but some residential uses do exist less than 500 feet from the proposed site on 21st and 22nd Streets. The noise assessment determined that the VLMF would not result in impacts to these noise-sensitive receivers.

13.3.1.3 Light Rail Alternative – Sugar Creek Design Option

Table 13-4 shows the impact assessment results for noise Category 1 and 2 land uses (residences, quiet parks). No Category 3 land uses (schools and churches) would have predicted noise levels that would result in an impact. Impacts were predicted at two separate impact locations along the extent of the design option. One moderate impact would be predicted at an individual residence at 5234 North Tryon Street. At the Pines Mobile Home Park, a total of 26 individual residential building properties would be moderately impacted. The selection of the Light Rail Alternative – Sugar Creek Design Option would not eliminate any of the predicted impacts for the proposed Light Rail Alternative.

Table 13-4
Noise Impact General Assessment (2009) Category 1 and 2 Land Uses
Light Rail Alternative – Sugar Creek Design Option

Description	Land Use	Existing Ldn (dBA)	Speed (mph)	Dist to Source (feet)	Impact Thresholds		Project-Related Prediction Ldn (dBA)	Type/# of Impact
					Impact	Severe		
House, 5234 North Tryon Street	SFR	70	45	70	64	69	67.4	Moderate 1-SFU

Table 13-4 (continued)
Noise Impact General Assessment (2009) Category 1 and 2 Land Uses
Light Rail Alternative – Sugar Creek Design Option

Description	Land Use	Existing Ldn (dBA)	Speed (mph)	Dist to Source (feet)	Impact Thresholds		Project-Related Prediction Ldn (dBA)	Type/# of Impact
					Impact	Severe		
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	54	35	195	55	61	59.1	Moderate 4-SFU
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	54	35	300	55	61	56.6	Moderate 22-SFU

SFR = Single-family Residential, MFR = Multi-family Residential, MU = Mixed use, SFU = Single-family unit, MFU = Multi-family unit
Source: STV, *Noise and Vibration Technical Report*, 2010

Train Operations / Grade Crossings / Substations:
A residence located at 5234 North Tryon Street/US-29 along the Light Rail Alternative – Sugar Creek Design Option would be affected by noise levels from project substations. At this location, predicted substation noise levels were also added to those noise levels predicted for the light rail operations and grade crossings.

Stations and Park-and-Ride Lots:
The only station that has sensitive noise receptors nearby would be the Old Concord Station – Sugar Creek Design Option. However, because this station would include an access road that is very close to a sensitive receptor (approximately 50 feet from the Crossroads Charter High School) its potential noise impact was conservatively included in the total noise impact assessment conducted for the high school. Results concluded that there would be no impact at the school.

Wheel Squeal: No sections of the Light Rail Alternative – Sugar Creek Design Option would have a track radius of less than 450 feet. As a result, it is not anticipated that sensitive noise receptors would be affected by wheel squeal.

13.3.2 Vibration Impacts

13.3.2.1 No-Build Alternative

No project-generated vibration impacts would occur under the No-Build Alternative.

13.3.2.2 Light Rail Alternative

Vibration predictions were made for both residential and institutional land uses (schools and churches) along the proposed light rail alignment. The results indicate that vibration impacts would occur at one receptor at 342 St. Anne Place, located fifty feet north of the proposed Light Rail Alternative alignment (Figure 13-5). Because this impact is within one dB of the vibration criteria level, a more detailed assessment of the proposed Light Rail Alternative would need to be conducted so that a more accurate determination of actual impact, if any, can be made. While there are other neighboring receptors located along the right-of-way, the next closest vibration-sensitive property would be located 70 feet from the alignment. At this distance and beyond, the assessment indicates that no additional vibration impacts would be projected to occur.

Charlotte Research Institute at UNC Charlotte: Screening for sensitive Category 1 vibration is based on a distance of 450 feet. Land uses for this category typically include vibration-sensitive research and manufacturing activities, hospitals with vibration-sensitive equipment and university research operations. However, the degree of sensitivity to vibration is dependent upon the specific equipment that would be affected by the vibration.

CRI personnel indicate that for several existing and future buildings, campus research activities would require vibration limits in the range of 42 – 60 VdB. To mitigate current vibration on sensitive equipment, several of the existing CRI campus buildings including Grigg Hall and the Bioinformatics Building (which is currently in the process of being constructed) employ the use of a dual vibration isolation system in the form of: 1) a central slab mounted on bedrock and isolated from the rest of the building; and, 2) individual mechanical vibration isolation platforms tailored for the various pieces of sensitive equipment.

Several buildings planned for future construction including the Epic Building and the Portal building will also include vibration sensitive research for which the required vibration limits may be even stricter at 36 VdB. Based on these strict vibration requirements, the vibration levels for the existing environment (which does not include existing rail activity) described previously (approximately 46 VdB) would already require some form of mitigation for much of their research activities. Consequently, the vibration criteria described in Table 13-1 would be inadequate to properly assess potential impacts from light rail on these buildings.

Because vibration limits for Category 1 are based on acceptable vibration levels for moderately vibration-sensitive equipment, such as optical microscopes and electron microscopes with vibration isolation systems, defining limits for equipment that is even more sensitive requires a detailed review of the specific equipment involved, the vibration frequencies at which they are sensitive and detailed field measurements of soil vibration characteristics. This type of review is usually performed during the detailed assessment associated with the final design phase of a project and not as part of the Draft EIS due to the increased level of specificity needed in the engineering design to properly assess the proposed impacts. The need for a more detailed assessment, along with continuing coordination with the Charlotte Research Institute, is acknowledged and affirmed.

13.3.2.3 Light Rail Alternative – Sugar Creek Design Option

No additional impacts over the proposed Light Rail Alternative would be observed at any of the vibration-sensitive receptor locations for the design option. The predicted impact at 342 St. Anne Place for the Light Rail Alternative would be eliminated as the design option would not pass by this receptor.

13.4 Mitigation

Each of the predicted impacts will be confirmed during a detailed assessment to be conducted following the Draft EIS public and agency comment period. Specific mitigation measures will be designed for each affected property during this assessment and will be documented in the Final EIS. These measures will be based on more accurate and specific operational engineering and environmental data that will be available for use in a detailed noise assessment. As such, they may differ with those mitigation measures recommended here.

13.4.1 Noise Mitigation

The FTA guidance states that for moderate impacts, mitigation will be incorporated into the project when it is considered reasonable and practicable. The evaluation of specific mitigation measures will include the overall noise reduction potential, the costs, the affect on transit operations and maintenance, and any new environmental impacts, such as visual affects, that may result from the proposed mitigation. Of the 12 moderate impacts, most are just over the impact threshold for a moderate impact, and therefore, the costs to provide mitigation will outweigh the benefit of mitigation. Specifically, mitigation is not anticipated for InTown Suites, Residence Inn by Marriott, Carolinas Medical Center-University, Kirk Farm Fields Wetland Viewing area, and Mallard Creek Apartments Buildings 5 and 7.

For severe impacts, FTA requires mitigation to be incorporated into a project unless there are extenuating circumstances to prevent it. The goal is to gain substantial reductions in noise level. Examples of general noise mitigation measures include, but are not limited to: operational restrictions; the use of vehicle skirts and resilient or damped wheels; sound barriers; and buffer zone acquisitions. Descriptions of the most practical mitigation recommendations are included in the following sections. Mitigation measures assume that the rail system will be maintained in its as-new condition.

13.4.1.1 Light Rail Alternative

The following includes potential mitigation measures that will be considered to mitigate the identified impacts of the proposed Light Rail Alternative, where sufficient decibel reduction can be achieved through mitigation. A detailed assessment will be conducted during final design to confirm the potential for impact and coordination with affected parties will occur at that time to select the most appropriate mitigation measures. A matrix of needed decibel reductions by each resource is provided in Table 13-5.

Rail Vehicle Skirts:
Depending upon the exact level of effectiveness, the modification of light rail vehicle skirts from a simple aesthetic use to one that could result in noise attenuation could eliminate or significantly reduce many of the impacts. This assumes a six to ten dB range of attenuation for wheel/rail noise. Impacts at the Pines Mobile Home Park could be eliminated. Impacts at the Mallard Creek Apartments could be reduced, but not eliminated.

Sound Barriers:
Sound barriers can either be located close to the source, at the affected receptor or somewhere in between. Sound barriers could be effective in eliminating severe and moderate impacts for many of the affected properties. A solid, impervious wall that is sufficiently high to block the direct view of the noise source could typically reduce community noise levels at locations within approximately 200 feet of the track. Sound barriers could be effective in eliminating moderate impacts for the Pines Mobile Home Park. For all potential barrier locations, the use of barriers should also require the simultaneous consideration of visual impacts. For the two locations that would be affected by wheel squeal, namely the UNC Charlotte Laurel Hall and Kirk Farm Fields, barriers located very close to the track could significantly reduce the level of wheel squeal by as much as 15 dB.

Resilient or Damped Wheels:
Resilient wheels are extremely efficient at attenuating wheel squeal. For the locations at UNC Charlotte Laurel Hall and Kirk Farm Fields, the noise impact from wheel squeal could likely be eliminated with reductions ranging from ten to 20 dB depending upon the frequency characteristics of the squeal noise.

Building Sound Insulation:
Building sound insulation most typically involves caulking and sealing gaps in the building envelope and installation of specially designed windows and solid-core doors. Depending on the quality of the original windows, such treatments can provide noise reductions as much as five to ten dB or more to building interiors. (Note: Noise impacts have been calculated based on distances to property exteriors). One or more of the apartment buildings at Mallard Creek Apartments and the Pines Mobile Home Park could benefit from sound insulation.

13.4.1.2 Light Rail Alternative – Sugar Creek Design Option

The following includes potential mitigation measures that will be considered to mitigate the identified impacts of the Light Rail Alternative – Sugar Creek Design Option. A detailed assessment will be conducted to confirm the impacts described herein and identify the most effective and practical mitigation techniques. CATS will coordinate with the affected property owners during the evaluation of mitigation effectiveness.

Rail Vehicle Skirts:
Depending upon the exact level of effectiveness, the use of vehicle skirts could eliminate many of the impacts projected for the Light Rail Alternative – Sugar Creek Design Option. Only slightly moderate impacts would remain at the Pines Mobile Home Park.

Sound Barriers:
Sound barriers could be effective in eliminating moderate impacts for the Pines Mobile Home Park. However, noise from crossing bells may not be adequately blocked for all receptors. For all potential barrier locations, the use of barriers would also require the simultaneous consideration of visual impacts.

Table 13-5
Needed Decibel Reduction for the Light Rail Alternative

Receptor Description	Land Use[1]	Noise Source to Receptor Distances (feet)[2]			Type of Impact	# Impacts[1]	Needed Decibel Reduction to Eliminate Impact[3]
		Distance to Track	Distance to Grade Crossing	Distance to Substation			
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	**230**	1,200	n/a	Moderate	4-SFU	3.1
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	**300**	1,200	n/a	Moderate	22-SFU	2.0
InTown Suites, 110 Rocky River Road	Hotel	**220**	1,100	**220**	Moderate	1-Hotel	0.6
Residence Inn by Marriott, 8503 North Tryon Street at Ken Hoffman Drive	Hotel	112	**200**	n/a	Moderate	1-Hotel	0.6
Carolinas Medical Center-University 8800 North Tryon Street	Hospital	245	**290**	n/a	Moderate	1-Hospital	1.0
Campus Housing, UNC Charlotte Laurel Hall	Residence Hall	**218**	n/a	n/a	Potential Wheel Squeal	1-Residence Hall	Wheel squeal elimination
Mallard Creek Apartments, 420 Michelle Linnea Drive (1)	MFR	**105**	**300**	n/a	Severe	1-MFU	6.7
Mallard Creek Apartments, 420 Michelle Linnea Drive (2)	MFR	240	**240**	n/a	Moderate	1-MFU	4.2
Mallard Creek Apartments, 420 Michelle Linnea Drive (3)	MFR	300	**390**	n/a	Moderate	1-MFU	2.5
Mallard Creek Apartments, 420 Michelle Linnea Drive (4)	MFR	**125**	**500**	n/a	Moderate	1-MFU	5.6
Mallard Creek Apartments, 420 Michelle Linnea Drive (5)	MFR	310	**530**	n/a	Moderate	1-MFU	0.7
Mallard Creek Apartments, 420 Michelle Linnea Drive (6)	MFR	190	**650**	n/a	Moderate	1-MFU	2.4
Mallard Creek Apartments, 420 Michelle Linnea Drive (7)	MFR	320	**750**	n/a	Moderate	1-MFU	0.2
Mallard Creek Apartments, 420 Michelle Linnea Drive (8)	MFR	**100**	**100**	n/a	Severe	1-MFU	9.8
Kirk Farm Fields Wetland Viewing Area, North Tryon Street/US-29 at Mallard Creek Church Road	Park	150	**225**	n/a	Moderate/ Potential Wheel Squeal	1-Park	0.1/Wheel squeal elimination

[1] SFR = Single-family residential, MFR = Multi-family residential, SFU = Single-family unit, MFU = Multi-family unit
[2]For each property, the source to receptor distances when bolded represents the dominant noise sources affecting that property.
[3]No mitigation is proposed for reductions equal or less than 1 decibel
Source: STV, *Noise and Vibration Technical Report,* 2010; STV, *Noise and Vibration Technical Report Addendum #2,* 2010.

Building Sound Insulation:
The single-family home at 5234 North Tryon Street/US-29 could benefit from sound insulation as it is the only affected property in the immediate area. Assuming a five to ten dB reduction, moderate impacts could be eliminated.

Relocate or Insulate Substation:
For the single-family home at 5234 North Tryon Street/US-29, relocating or using a sound proof enclosure for the substation nearby would reduce the level of noise impact. This could be used separately or combined with the building sound insulation.

A matrix of needed decibel reductions for properties that could experience an increase in predicted noise levels is provided in Table 13-6.

Table 13-6
Needed Decibel Reductions for the Light Rail Alternative – Sugar Creek Design Option

Receptor Description	Land Use	Noise Source to Receptor Distances (feet)			Type/# of Impact	Needed Decibel Reduction to Eliminate Impact
		Distance to Track	Distance to Grade Crossing	Distance to Light Rail Substation		
House, 5234 North Tryon Street	SFR	70	409	**85**	Moderate 1-SFU	3.4
Pines Mobile Home Park, 5635 North Tryon Street (1st Row)	SFR	195	**195**	n/a	Moderate 4-SFU	4.1
Pines Mobile Home Park, 5635 North Tryon Street (2nd Row)	SFR	300	**300**	n/a	Moderate 22-SFU	1.6

SFR = Single-family residential, SFU = Single-family unit
For each property, the source to receptor distances when bolded represents the dominant noise sources affecting that property.
Source: STV, *Noise and Vibration Technical Report,* 2010

13.4.2 Vibration Mitigation

13.4.2.1 Light Rail Alternative

Many vibration impacts can be controlled or eliminated by the use of several general control measures. As described in the FTA manual, these measures include:

- High Resilience Rail Fasteners
- Ballast Mats
- Floating Slab Track Bed
- Resilient Supported Ties

The vibration assessment indicates that only one residence, located at 342 St. Anne Place would experience a project-related vibration impact. However, the projected impact is less than 1 dB over the vibration threshold limit. Consequently, of the control measures listed previously, the use of ballast mats would be successful at effectively reducing the predicted vibration level below the FTA threshold.

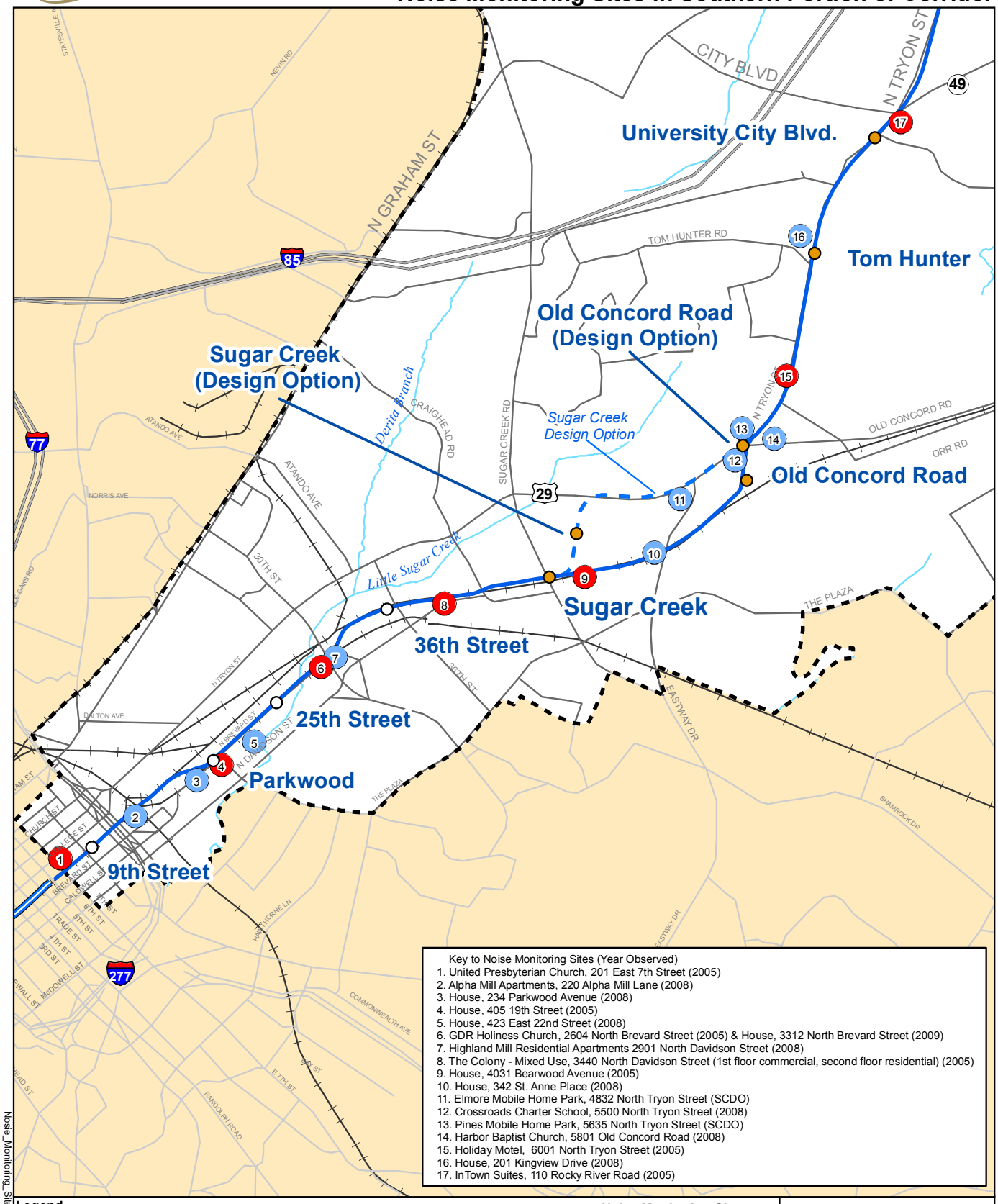
Several buildings within the UNC Charlotte campus were identified that could potentially be affected by vibration from the proposed Light Rail Alternative. Because of the sensitive nature of the research, a more detailed review of the potential vibration impact is required. A detailed assessment will be conducted during final design to confirm the impacts described herein and identify the most effective and practical mitigation techniques. CATS will coordinate with the affected property owners during the evaluation of mitigation effectiveness.

13.4.2.2 Light Rail Alternative – Sugar Creek Design Option

The proposed Light Rail Alternative – Sugar Creek Design Option would not result in vibration impacts. Therefore, mitigation measures are not proposed.

LYNX Blue Line Extension

Figure 13-4a
Noise Monitoring Sites in Southern Portion of Corridor



Key to Noise Monitoring Sites (Year Observed)
1. United Presbyterian Church, 201 East 7th Street (2005)
2. Alpha Mill Apartments, 220 Alpha Mill Lane (2008)
3. House, 234 Parkwood Avenue (2008)
4. House, 405 19th Street (2005)
5. House, 423 East 22nd Street (2008)
6. GDR Holiness Church, 2604 North Brevard Street (2005) & House, 3312 North Brevard Street (2009)
7. Highland Mill Residential Apartments 2901 North Davidson Street (2008)
8. The Colony - Mixed Use, 3440 North Davidson Street (1st floor commercial, second floor residential) (2005)
9. House, 4031 Bearwood Avenue (2005)
10. House, 342 St. Anne Place (2008)
11. Elmore Mobile Home Park, 4832 North Tryon Street (SCDO)
12. Crossroads Charter School, 5500 North Tryon Street (2008)
13. Pines Mobile Home Park, 5635 North Tryon Street (SCDO)
14. Harbor Baptist Church, 5801 Old Concord Road (2008)
15. Holiday Motel, 6001 North Tryon Street (2005)
16. House, 201 Kingview Drive (2008)
17. InTown Suites, 110 Rocky River Road (2005)

Legend

- Northeast Corridor Limits
- Light Rail Transit
- Design Option
- Proposed Stations
- Proposed Stations with Park-and-Ride
- LYNX Existing Ligh Rail Tranist
- Highway
- Highway (Future)
- Major Roads
- Railroads

Noise Monitoring Sites

- 2005 Noise Monitoring Sites
- 2008 Noise Monitoring Sites

N

0 0.25 0.5
Mile

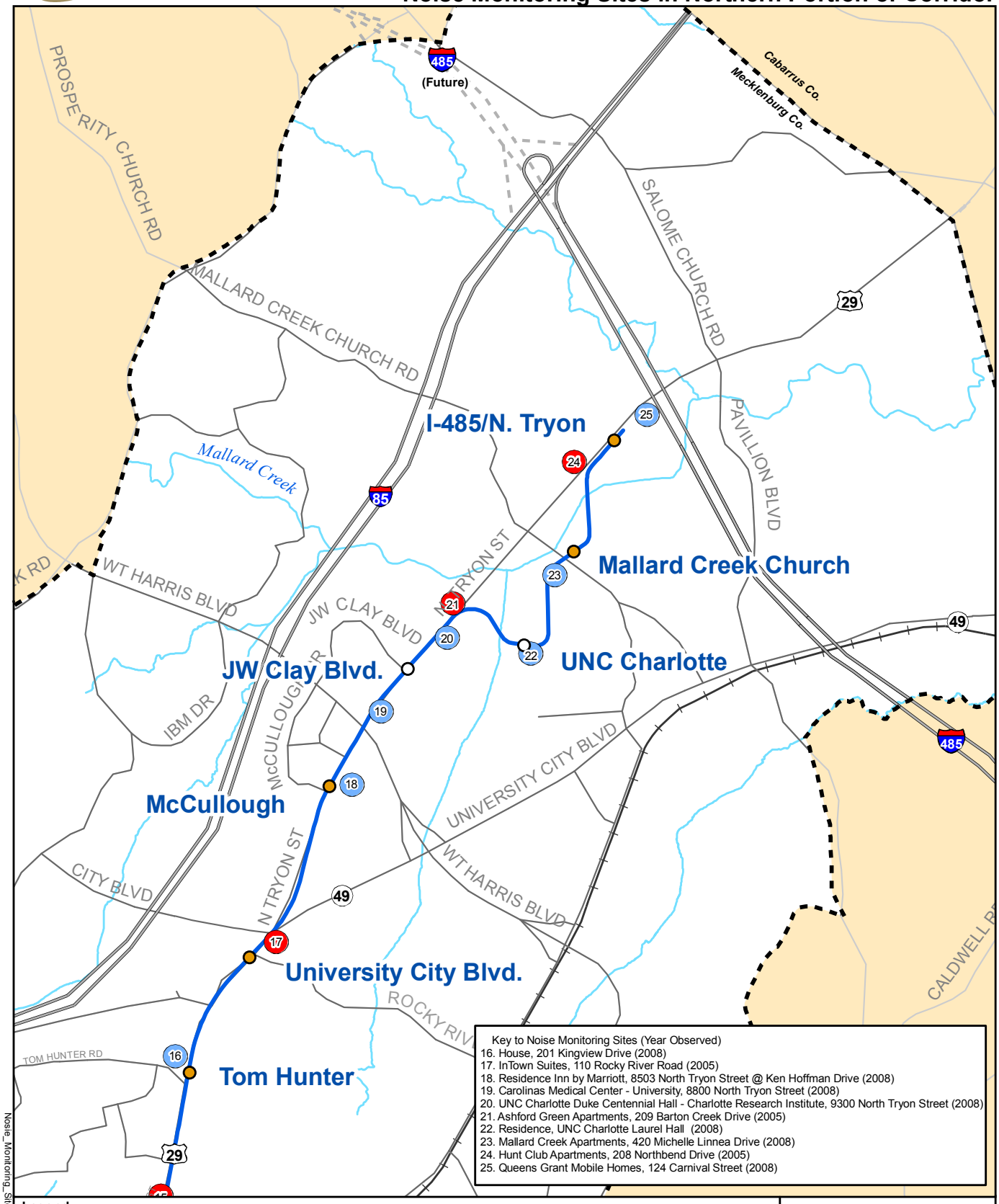
Data Source:
CATS, City of Charlotte GIS, and Mecklenburg County GIS, STV Field Investigation, 2009

11.20.09

Noise_Monitoring_Sites_Southern_Map_Fig.14-4a_Rev.00.pdf

LYNX Blue Line Extension

Figure 13-4b
Noise Monitoring Sites in Northern Portion of Corridor



Key to Noise Monitoring Sites (Year Observed)
16. House, 201 Kingview Drive (2008)
17. InTown Suites, 110 Rocky River Road (2005)
18. Residence Inn by Marriott, 8503 North Tryon Street @ Ken Hoffman Drive (2008)
19. Carolinas Medical Center - University, 8800 North Tryon Street (2008)
20. UNC Charlotte Duke Centennial Hall - Charlotte Research Institute, 9300 North Tryon Street (2008)
21. Ashford Green Apartments, 209 Barton Creek Drive (2005)
22. Residence, UNC Charlotte Laurel Hall (2008)
23. Mallard Creek Apartments, 420 Michelle Linnea Drive (2008)
24. Hunt Club Apartments, 208 Northbend Drive (2005)
25. Queens Grant Mobile Homes, 124 Carnival Street (2008)

Legend

- Northeast Corridor Limits
- Light Rail Transit
- Design Option
- Proposed Stations
- Proposed Stations with Park-and-Ride
- LYNX Existing Light Rail Transit
- Highway
- Highway (Future)
- Major Roads
- Railroads

Noise Monitoring Sites

- 2005 Noise Monitoring Sites
- 2008 Noise Monitoring Sites

N

0 0.25 0.5
Mile

Data Source:
CATS, City of Charlotte GIS, and Mecklenburg County GIS, STV Field Investigation, 2009

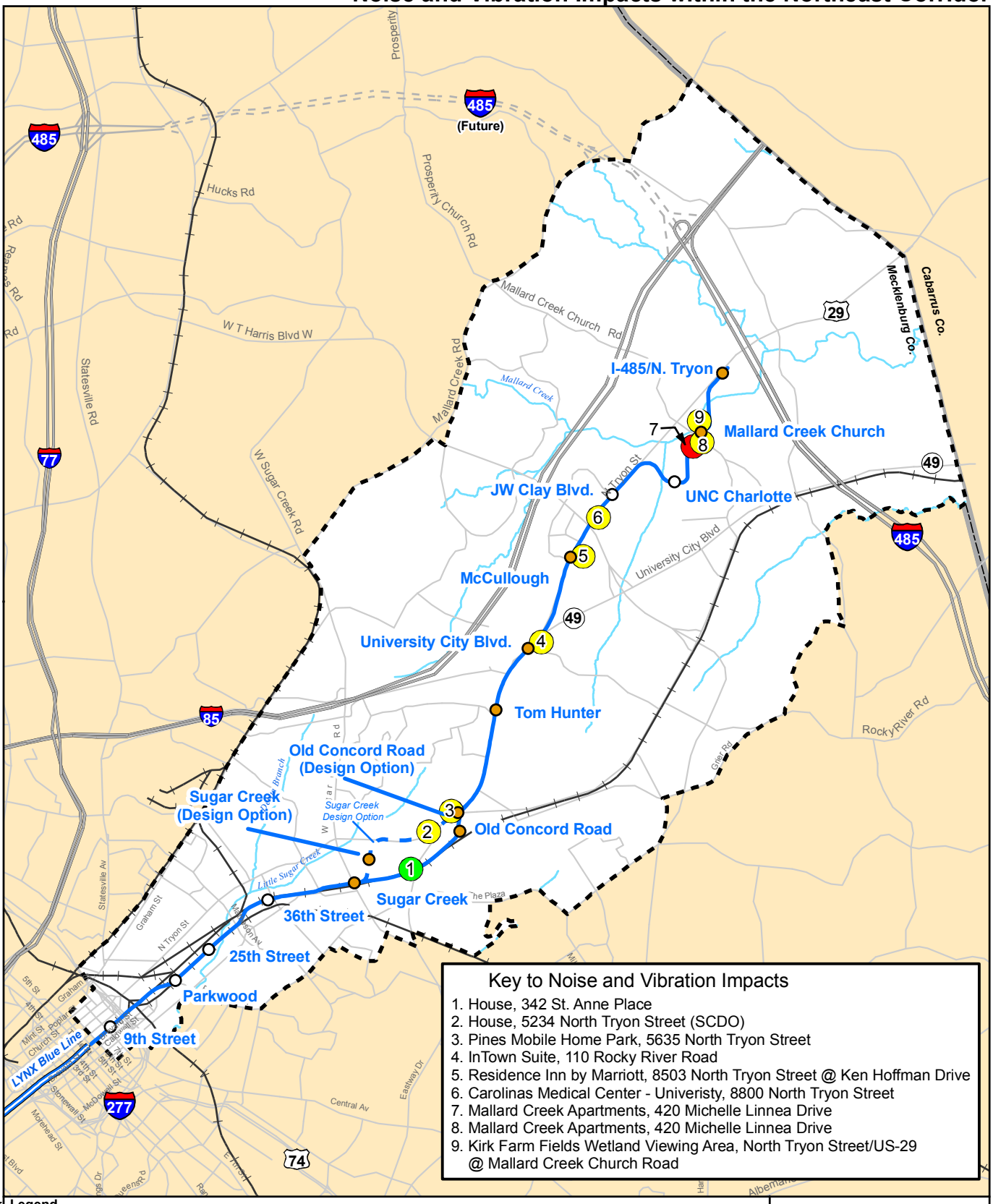
Noise_Monitoring_Sites_Northern_Map_Fig.14-4b_Rev.00.pdf

20.02.09

LYNX Blue Line Extension

Figure 13-5

Noise and Vibration Impacts within the Northeast Corridor



Key to Noise and Vibration Impacts

1. House, 342 St. Anne Place
2. House, 5234 North Tryon Street (SCDO)
3. Pines Mobile Home Park, 5635 North Tryon Street
4. InTown Suite, 110 Rocky River Road
5. Residence Inn by Marriott, 8503 North Tryon Street @ Ken Hoffman Drive
6. Carolinas Medical Center - Univeristy, 8800 North Tryon Street
7. Mallard Creek Apartments, 420 Michelle Linnea Drive
8. Mallard Creek Apartments, 420 Michelle Linnea Drive
9. Kirk Farm Fields Wetland Viewing Area, North Tryon Street/US-29 @ Mallard Creek Church Road

Legend

- Northeast Corridor Limits
- Proposed Light Rail Alternative
- Design Option
- Proposed Stations
- Proposed Stations with Park-and-Ride
- LYNX Existing Light Rail Transit
- Highway
- Major Roads
- Highway (Future)
- Streams
- Railroads
- County Line
- Moderate Noise Impact
- Severe Noise Impact
- Vibration Impact

0 0.5 1 Mile

Data Source:
CATS, City of Charlotte GIS, and Mecklenburg County GIS, STV Field Investigation, 2009

Noise & Vibration Impacts_Rev1.00.pdf

02.02.10